2006 National Weather Association Meeting *Cleveland, Ohio*

Abstract *15-19 October 2006*

High-Resolution Analysis Products to Support Severe Weather and Cloud-to-Ground Lightning Threat Assessments over Florida

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The Applied Meteorology Unit (AMU) located at the Kennedy Space Center (KSC)/Cape Canaveral Air Force Station (CCAFS) implemented an operational configuration of the Advanced Regional Prediction System (ARPS) Data Analysis System (ADAS), as well as the ARPS numerical weather prediction (NWP) model. Operational, high-resolution ADAS analyses have been produced from this configuration at the National Weather Service in Melbourne, FL (NWS MLB) and the Spaceflight Meteorology Group (SMG) over the past several years. Since that time, ADAS fields have become an integral part of forecast operations at both NWS MLB and SMG. To continue providing additional utility, the AMU has been tasked to implement visualization products to assess the potential for supercell thunderstorms and significant tornadoes, and to improve assessments of short-term cloud-to-ground (CG) lightning potential. This paper and presentation focuses on the visualization products developed by the AMU for the operational high-resolution ADAS and ARPS at the NWS MLB and SMG.

The two severe weather threat graphics implemented within ADAS/ARPS are the Supercell Composite Parameter (SCP) and Significant Tornado Parameter (STP). The SCP was designed to identify areas with supercell thunderstorm potential through a combination of several instability and shear parameters. The STP was designed to identify areas that favor supercells producing significant tornadoes (F2 or greater intensity) versus non-tornadic supercells. Both indices were developed by the NOAA/NWS Storm Prediction Center (SPC) and were normalized by key threshold values based on previous studies. The indices apply only to discrete storms, not other convective modes.

In a post-analysis mode, the AMU calculated SCP and STP for graphical output using an ADAS configuration similar to the operational set-ups at NWS MLB and SMG . Graphical images from ADAS were generated every 15 minutes for 13 August 2004, the day that Hurricane Charley approached and made landfall on the Florida peninsula. Several tornadoes struck the interior of the Florida peninsula in advance of Hurricane Charley's landfall during the daylight hours of 13 August. Since SPC had previously examined this case using SCP and STP graphics generated from output of the Rapid Update Cycle (RUC) model, this day served as a good benchmark to compare and validate the high-resolution ADAS graphics against the smoother RUC analyses, which serves as background fields to the ADAS analyses. The ADAS-generated SCP and STP graphics have been integrated into the suite of products examined operationally by NWS MLB forecasters and are used to provide additional guidance for assessment of the near-storm environment during convective situations.

A study published in 1999 identified CG lightning initiation signatures in the vicinity of KSC based on reflectivity thresholds from the WSR-88D at key isothermal layers in the atmosphere. The authors interpolated radar data from the Melbourne, FL WSR-88D onto a Cartesian grid with 1-km horizontal spacing and 0.5-km vertical spacing. Using results from 39 total storm cells in the KSC area (31 with CG lightning and 8 without), the authors computed skill scores of various lightning initiation signatures based on reflectivity thresholds at the -10°C, -15°C, and -20°C levels. The most skillful reflectivity thresholds were > 40 dBZ at -10°C (79% critical success index [CSI], 7.5 min median lag time), > 30 dBZ at -15°C (71% CSI, 12.5 min median lag time), and > 20 dBZ at -20°C (63% CSI, 10.5 min median lag time). The skill decreased with colder temperatures due to higher false alarm rates at the indicated reflectivity thresholds. With only 8 non-lightning cases, there may be some representativeness error in the skill scores with this limited database.

The AMU developed a 4-panel graphic that displays the composite reflectivity interpolated to the ADAS analysis grid, and each of the reflectivity thresholds at the -10°C, -15°C, and -20°C isotherms, as described above. The goal was to create a product that would provide forecasters with a meaningful decision aid in nowcasting CG lightning initiation threats in real time. To accomplish this and to keep the skill scores meaningful, an ADAS grid was devised at the same resolution as that used in the 1999 study described above. The horizontal and vertical dimensions were modified in order to maximize the analysis domain while minimizing the amount of computational time it takes to complete the analysis cycle. Ultimately, it will be most helpful to create an operational scheme where a 1-km ADAS lightning product is produced every 5 min, in order to generate output for each volume scan of the WSR-88D. Sample graphics will be shown from the 13 August 2004 convection associated with Hurricane Charley's outer bands and compared to corresponding data from the National Lightning Detection Network.